US009319449B2

(12) **United States Patent**
Harpster

(10) **Patent No.: US 9,319,449 B2**
(45) **Date of Patent: Apr. 19, 2016**

(54) **METHOD, APPARATUS, AND COMPUTER PROGRAM PRODUCT FOR PROCESSING DATA REQUESTS**

(75) Inventor: **Todd Harpster**, Eagan, MN (US)

(73) Assignee: **McKesson Financial Holdings**, Hamilton (BM)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 743 days.

(21) Appl. No.: **13/537,534**

(22) Filed: **Jun. 29, 2012**

(65) **Prior Publication Data**

US 2014/0006475 A1 Jan. 2, 2014

(51) **Int. Cl.**

G06F 15/16	(2006.01)
H04L 29/08	(2006.01)
G06F 17/30	(2006.01)
H04L 29/06	(2006.01)

(52) **U.S. Cl.**

CPC ***H04L 67/02*** (2013.01); ***G06F 17/30861*** (2013.01); ***H04L 63/20*** (2013.01); ***H04L 67/2804*** (2013.01)

(58) **Field of Classification Search**

CPC ... G06F 17/30; G06F 17/30861; H04L 12/56; H04L 29/06

USPC 709/202

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,055,236 A *	4/2000	Nessett	.....	H04L 29/12009 370/389
7,653,634 B2	1/2010	Mathur		
2002/0107743 A1 *	8/2002	Sagawa	.....	G06Q 10/10 705/17
2004/0015368 A1 *	1/2004	Potter	.....	H04L 67/10 709/201
2005/0027818 A1 *	2/2005	Friedman	.....	H04L 29/06 709/217
2005/0063335 A1 *	3/2005	Shenfield	.....	H04M 3/4938 370/329
2008/0178278 A1 *	7/2008	Grinstein	.....	H04L 63/0227 726/12
2013/0275492 A1 *	10/2013	Kaufman	.....	H04L 63/029 709/203

OTHER PUBLICATIONS

Cloud Gateway to Private Data Center, Mar. 8, 2012.*

"Cloud Gateway to Private Data Center"; Dated Mar. 8, 2012; pp. 1-4.

Christian Weyer's Blog; "When you think things are not possible: WCF duplex callbacks through NATs and firewalls—safe and secure"; dated Apr. 27, 2007; pp. 1-9.

"HTTP Tunnel"; Networking Products for Corporation Communications; Downloaded from http://www.http-tunnel.com/html/ on Aug. 20, 2012; 1 Page.

"Reverse HTTP"; Downloaded from http://reversehttp.net/reverse-http-spec.html on Aug. 20, 2012; pp. 1-12.

* cited by examiner

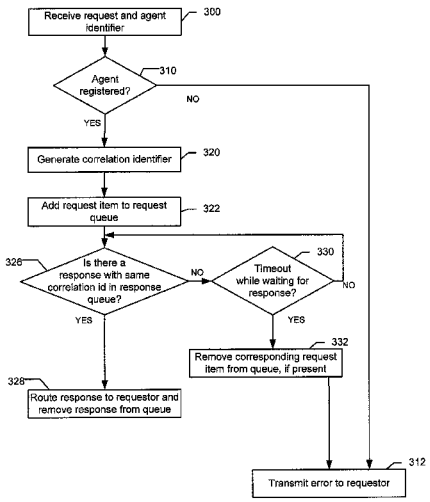
Primary Examiner — Hee Soo Kim

(74) *Attorney, Agent, or Firm* — Alston & Bird LLP

(57) **ABSTRACT**

A method for managing data requests is provided. Two asynchronous processes are provided for managing communication with a requestor and an agent via a gateway server. The method may include receiving a request and agent identifier from a requesting web application and generating a correlation identifier to associate with the request. The request and correlation identifier may be routed to a registered agent of a private data center. A response may be returned and routed to the requestor based on the correlation identifier. Corresponding apparatuses and computer program products are also provided.

10 Claims, 6 Drawing Sheets



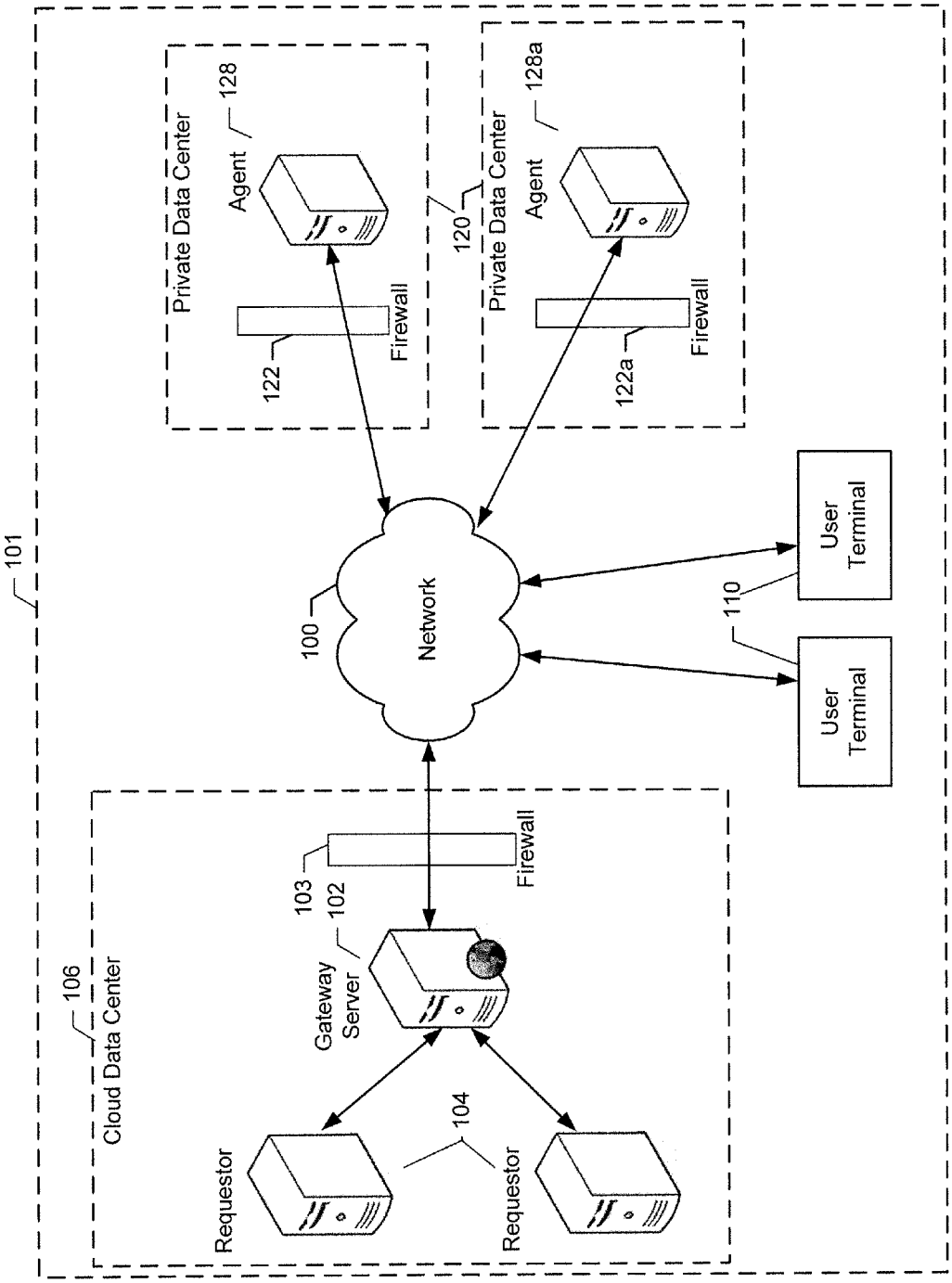

101
Private Data Center
Agent
128
122
Firewall
120
Private Data Center
Agent
128a
122a
Firewall
Network
100
User Terminal
110
User Terminal
Firewall
103
102
Gateway Server
106
Cloud Data Center
Requestor
104
Requestor

FIG. 1

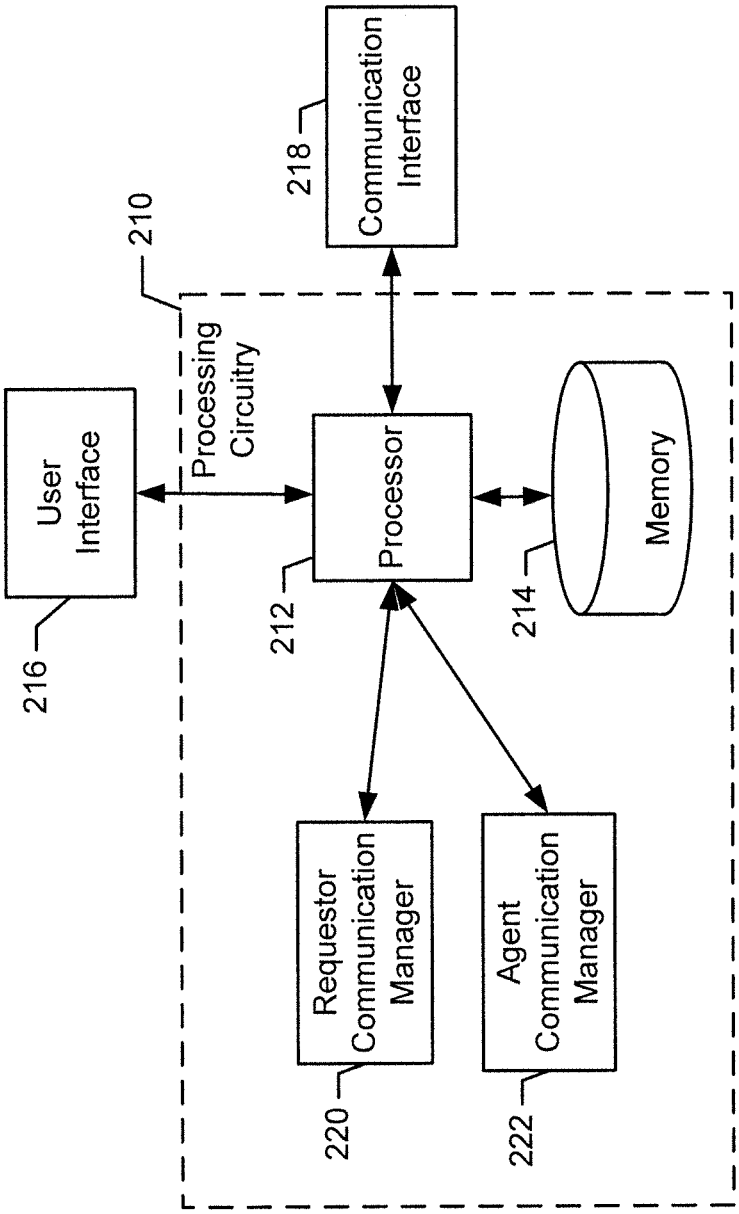

Communication Interface
218
210
Processing Circuitry
User Interface
Processor
Memory
216
212
214
Requestor Communication Manager
Agent Communication Manager
220
222

FIG. 2

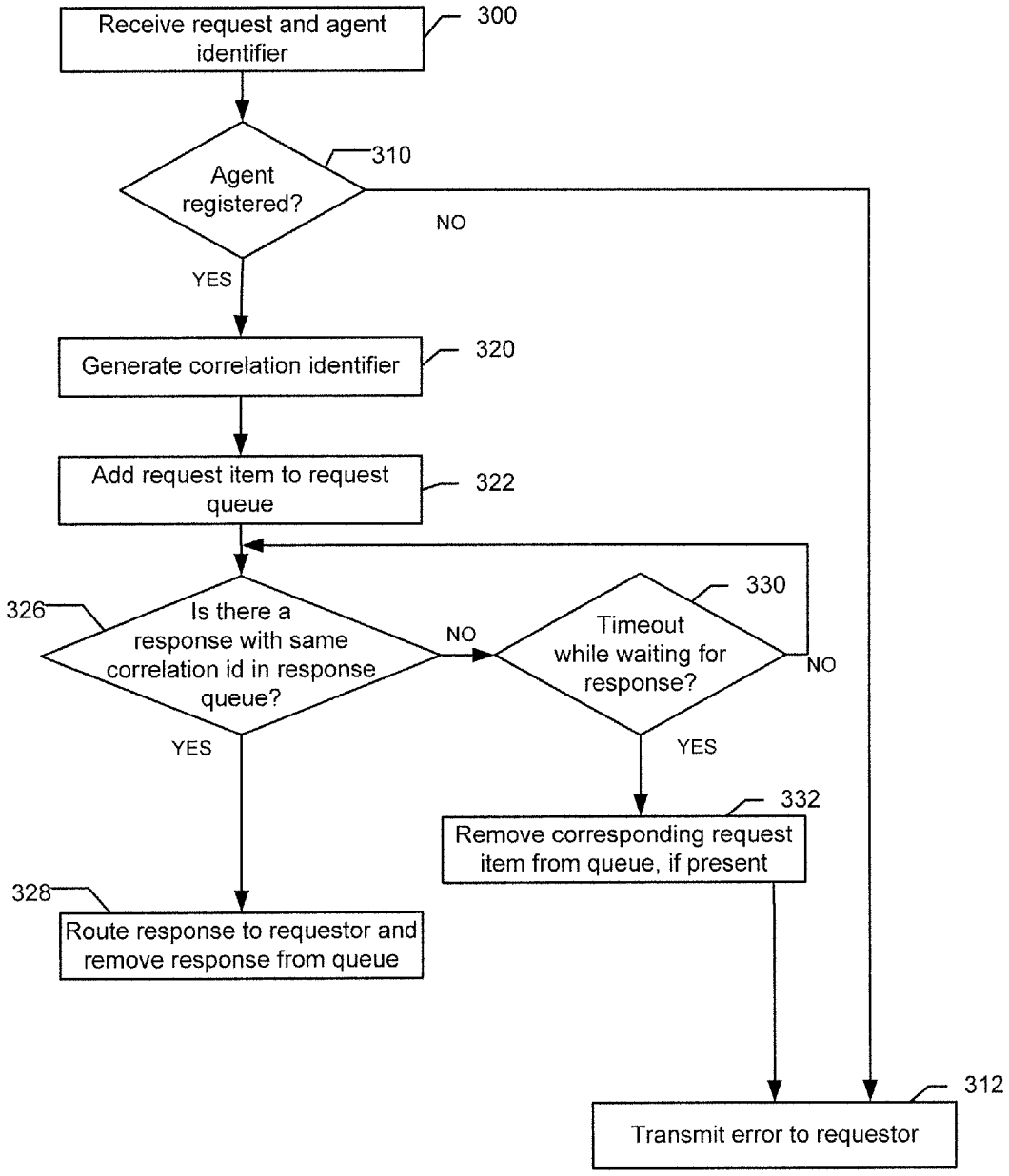

Receive request and agent identifier
300
Agent registered?
310
NO
YES
Generate correlation identifier
320
Add request item to request queue
322
326
Is there a response with same correlation id in response queue?
NO
330
Timeout while waiting for response?
NO
YES
YES
332
Remove corresponding request item from queue, if present
328
Route response to requestor and remove response from queue
312
Transmit error to requestor

FIG. 3A

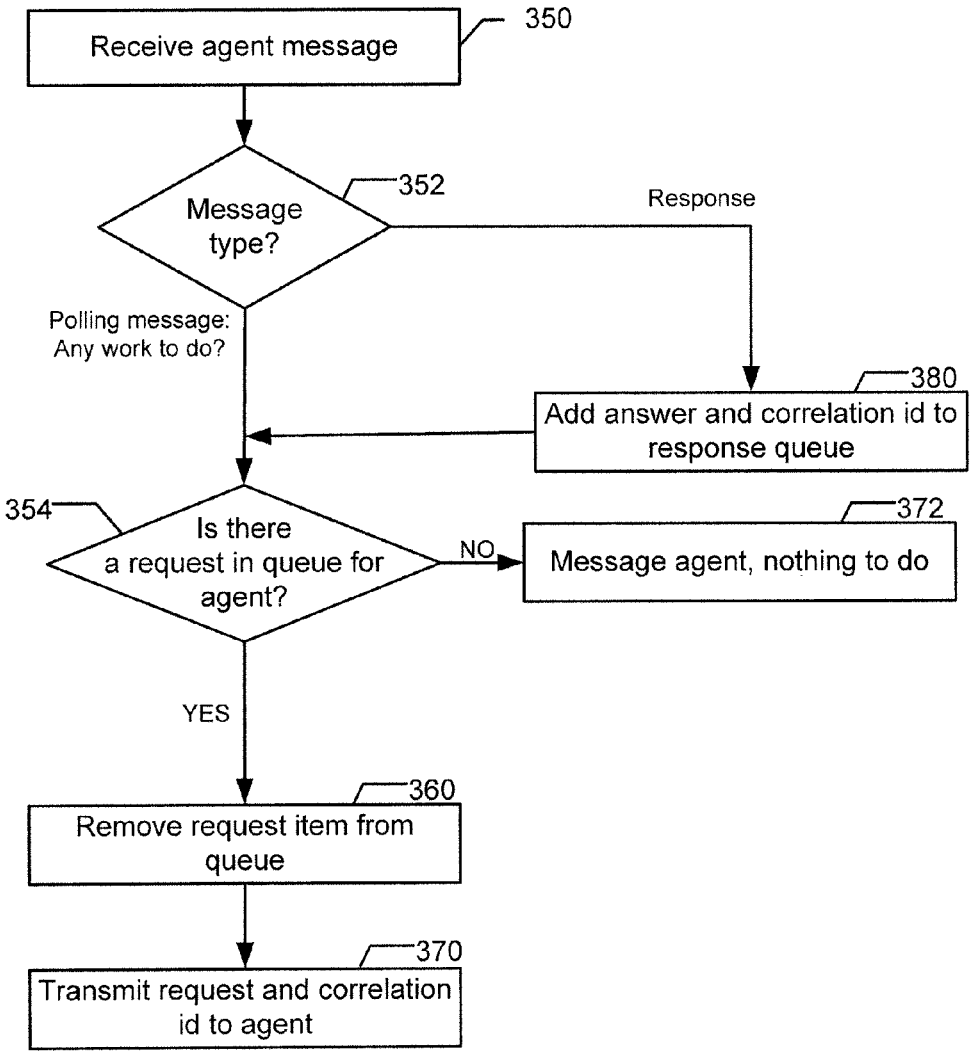

Receive agent message
350
Message type?
352
Response
Polling message: Any work to do?
Add answer and correlation id to response queue
380
354
Is there a request in queue for agent?
NO
Message agent, nothing to do
372
YES
Remove request item from queue
360
Transmit request and correlation id to agent
370

FIG. 3B

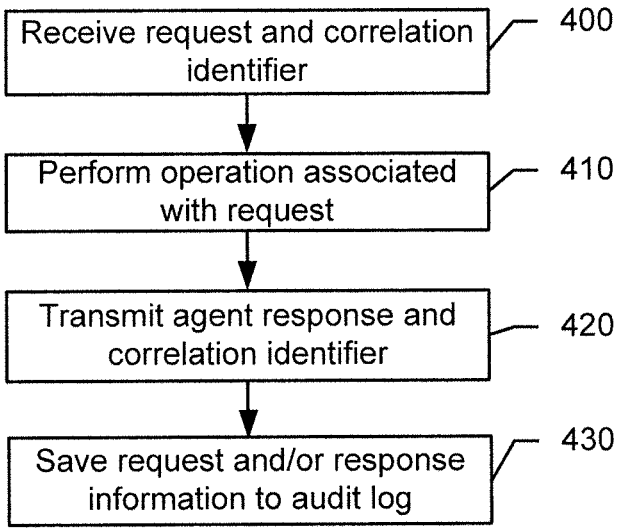

Receive request and correlation identifier
400
Perform operation associated with request
410
Transmit agent response and correlation identifier
420
Save request and/or response information to audit log
430

FIG. 4

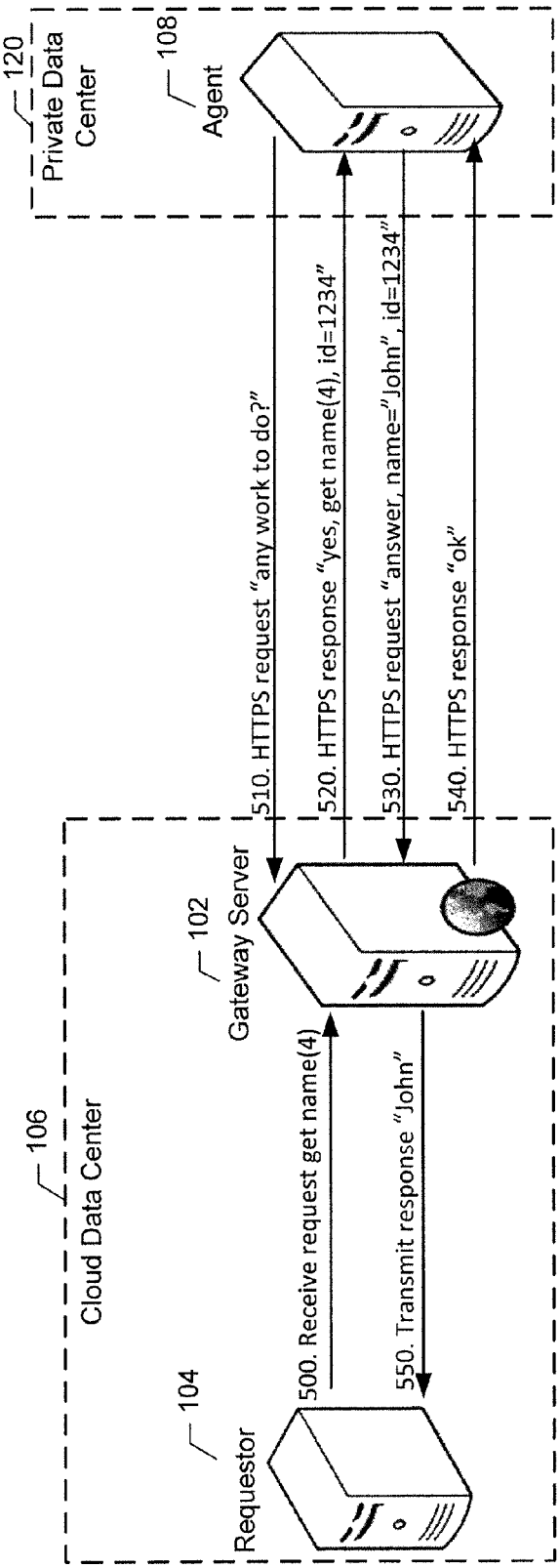

120
Private Data Center
108
Agent
510. HTTPS request "any work to do?"
520. HTTPS response "yes, get name(4), id=1234"
530. HTTPS request "answer, name="John", id=1234"
540. HTTPS response "ok"
102
Gateway Server
106
Cloud Data Center
500. Receive request get name(4)
550. Transmit response "John"
104
Requestor

FIG. 5

METHOD, APPARATUS, AND COMPUTER PROGRAM PRODUCT FOR PROCESSING DATA REQUESTS

TECHNOLOGICAL FIELD

Embodiments of the present invention relate generally to computer technology and, more particularly, relate to methods, apparatuses, and computer program products for processing data requests.

BACKGROUND

The widespread use of modern computing technology has led to an increasing demand for data to be made readily accessible by web applications via the internet. As the amount of data collected and stored in private databases continues to increase, so does the need for efficient and secure methods to retrieve such data. Some institutions may access third party servers or data centers in order to fully utilize available data and improve upon web applications offered to clients.

Some methods for data retrieval from private data centers may not fully meet demands for efficient and secure data retrieval. Some may introduce security vulnerabilities, putting customer data at risk to hackers or the like. Some techniques may not be able to withstand the volume demanded by requesting web applications, and the efficiency or performance of a system may consequently decline during peak usage.

BRIEF SUMMARY OF SOME EXAMPLE EMBODIMENTS

Methods, apparatuses, and computer program products are therefore provided for processing data requests. A method is provided for receiving a request and an agent identifier from a requestor, generating a correlation identifier associated with the request, routing the request and associated correlation identifier to an agent associated with the agent identifier, receiving an agent response comprising an answer and a correlation identifier, and routing the answer of the agent response to a requestor based on the correlation identifier. The receiving a request, generating a correlation identifier, and routing an answer may be performed asynchronously from routing the request and receiving an agent response.

In some embodiments, the method includes adding the request, agent identifier, and associated correlation identifier as a request item to a request queue, and routing the request includes retrieving the request item from the request queue, and transmitting the request and associated correlation identifier of the request item to an agent associated with the agent identifier. In some embodiments, the request queue is associated with an agent.

According to some embodiments, the method includes adding the agent response to a response queue, and routing the answer includes retrieving the agent response from a response queue, and transmitting the answer associated with the agent response to a requestor based on the correlation identifier associated with the agent response. In some embodiments, the agent response further comprises a security certificate identifying a registered agent.

In some embodiments, the method includes comprising transmitting an error response to a requestor in an instance when a response to a request is not received within a specified time limit and/or an agent identifier is not registered. According to some embodiments, the request and associated correlation identifier may be routed to the agent in the form of a hypertext transfer protocol secure response, in response to a polling hypertext transfer protocol secure request received from the agent. The agent response is received as a hypertext transfer protocol secure request.

In some embodiments, the request and associated correlation identifier may be routed to the agent via a WebSocket connection and the agent response may be received via the Web Socket connection. The agent identifier may comprise at least one of a customer identifier, application name, or service name.

A computer program product is provided, including at at least one non-transitory computer-readable medium having computer-readable program instructions stored therein, the computer-readable program instructions comprising instructions. The instructions, when performed by an apparatus, are configured to cause the apparatus to receive a request and an agent identifier from a requestor, generate a correlation identifier associated with the request, route the request and associated correlation identifier to an agent associated with the agent identifier, receive an agent response comprising an answer and a correlation identifier, and route the answer of the agent response to the requestor based on the correlation identifier. The receiving a request, generating a correlation identifier, and routing an answer is performed asynchronously from the routing the request and receiving an agent response.

In some embodiments, the instructions may cause the apparatus to add the request, agent identifier, and associated correlation identifier as a request item to a request queue. Routing the request includes retrieving the request item from the request queue and transmitting the request and associated correlation identifier of the request item to an agent associated with the agent identifier.

In some embodiments, the instructions further cause the apparatus to add the agent response to a response queue. Routing the answer may include retrieving the agent response from the response queue, and transmitting the answer associated with the agent response to the requestor based on the correlation identifier associated with the agent response.

In some embodiments, a method is provided including managing communication with a requestor asynchronously from managing communication with an agent. Managing communication with the requestor may include receiving a request and an agent identifier from a requestor, generating, by a processor, a correlation identifier associated with the request, determining that an agent response comprising the correlation identifier has been received, and routing an answer associated with the agent response to the requestor. Managing communication with the agent may include determining that a request comprising an agent identifier associated with the agent has been received, routing the request and an associated correlation identifier to the agent, and receiving an agent response comprising an answer and the correlation identifier.

In some embodiments, managing communication with the requestor further comprises adding the request, agent identifier, and associated correlation identifier as a request item to a request queue, and routing the request comprises retrieving the request item from the request queue, and transmitting the request and associated correlation identifier of the request item to an agent associated with the agent identifier.

In some embodiments, managing communication with the agent further comprises adding the agent response to a response queue, and routing an answer comprises retrieving the agent response from the response queue and transmitting the answer associated with the agent response to the requestor based on the correlation identifier associated with the agent response.

According to some embodiments, an apparatus for processing data requests is provided, the apparatus comprising processing circuitry configured to manage communication with a requestor. The processing circuitry may be configured to cause the apparatus to receive a request and an agent identifier from a requestor, generate a correlation identifier associated with the request, determine that an agent response comprising the correlation identifier has been received, and route an answer associated with the agent response to the requestor. The processing circuitry may be further configured to manage communication with an agent, causing the apparatus to determine that a request comprising an agent identifier associated with the agent has been received, route the request and an associated correlation identifier to the agent, and receive an agent response comprising an answer and the correlation identifier.

In some embodiments, the processing circuitry configured to manage communication with the requestor may be further configured to cause the apparatus to at least add the request, agent identifier, and associated correlation identifier as a request item to a request queue. The processing circuitry configured to manage communication with the agent may be further configured to cause the apparatus to at least retrieve the request item from the request queue and transmit the request and associated correlation identifier of the request item to an agent associated with the agent identifier.

In some embodiments, the processing circuitry configured to manage communication with the agent may be further configured to cause the apparatus to at least add the agent response to a request queue. The processing circuitry configured to manage communication with the requestor may be further configured to cause the apparatus to retrieve the agent response from the response queue and transmit the answer associated with the agent response to the requestor based on the correlation identifier associated with the agent response.

The above summary is provided merely for purposes of summarizing some example embodiments of the invention so as to provide a basic understanding of some aspects of the invention. Accordingly, it will be appreciated that the above described example embodiments are merely examples and should not be construed to narrow the scope or spirit of the disclosure in any way. It will be appreciated that the scope of the disclosure encompasses many potential embodiments, some of which will be further described below, in addition to those here summarized.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Having thus described embodiments of the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. **1** illustrates a system for accessing a private data center according to some example embodiments;

FIG. **2** is a block diagram of a gateway server apparatus in accordance with some example embodiments;

FIGS. **3**A, **3**B and **4** illustrate flowcharts according to some example embodiments; and

FIG. **5** is a diagram illustrating operations according to an example embodiment.

DETAILED DESCRIPTION

Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout.

As used herein, where a computing device is described herein to receive data from another computing device, it will be appreciated that the data may be received directly from the other computing device and/or may be received indirectly via one or more intermediary computing devices, such as, for example, one or more servers, relays, routers, network access points, and/or the like. Similarly, where a computing device is described herein to transmit data to other computing device, it will be appreciated that the data may be sent directly to the other computing device or may be sent to the other computing device via one or more interlinking computing devices, such as, for example, one or more servers, relays, routers, network access points, and/or the like.

FIG. **1** illustrates a system **101** for managing data requests initiated in a cloud data center according to some example embodiments. It will be appreciated that the system **101** as well as the illustrations in other figures are each provided as an example of an embodiment(s) and should not be construed to narrow the scope or spirit of the disclosure in any way. In this regard, the scope of the disclosure encompasses many potential embodiments in addition to those illustrated and described herein. As such, while FIG. **1** illustrates one example of a configuration of a system for accessing a private data center, numerous other configurations may also be used to implement embodiments of the present invention.

The system **101** may include a cloud data center **106**, comprising a gateway server **102**, any number of requestors **104**, and/or a firewall **103**. For the purpose of simplicity, example embodiments described herein will consider the requestor(s) **104** to be an application server; however, it will be appreciated that the requestor may be any apparatus requesting access to a private data center. In this regard, requestor(s) **104** may support and/or provide application code written in a variety of languages. Requestor(s) **104** may be any type of computer program or component running in the Cloud data center. Cloud data center **106** may comprise any number of requestor(s) **104** and the any number of requestor(s) **104** may be implemented using any combination of languages and/or platforms. Although not illustrated in FIG. **1**, cloud data center **106** may further comprise any number of web servers. The web server(s) may be accessed via network **100** and communicate with requestor(s) **104** and/or gateway server **102**. A request to access a web server may be generated from a user terminal **110** and may cause requestor(s) **104** to generate a request as described herein.

Gateway server **102** may be an apparatus configured to manage data requests received from requestor(s) **104** via any of a variety of communication methods dependent upon the configuration of the cloud data center **106**. For example, in embodiments in which a gateway server **102** is disposed remotely from requestor(s) **104**, data requests may be provided to the gateway server **102** via an internal network, local area network (LAN), or any other type of network connection. In some example embodiments, requestor(s) **104** may be directly connected to gateway server **102**. In some embodiments, various requestor(s) **104** may be connected to gateway server **102** using a variety of communication methods.

Regardless of its connection to requestor(s) **104**, gateway server **102** may be connected to a network **100**, by a variety of connections, to access private data center(s) **120**. Network **100** may be embodied in a local area network, the Internet,

any other form of a network, or in any combination thereof, including proprietary private and semi-private networks and public networks. The network **100** may comprise a wired network, wireless network (e.g., a cellular network, wireless local area network, wireless wide area network, some combination thereof, or the like), or a combination thereof, and in some example embodiments comprises at least a portion of the Internet. In some embodiments, cloud data center **106** may comprise a firewall **103** to protect the cloud data center **106** from unauthorized transmissions in and out of the cloud data center **106**. Firewall **103** may be implemented on the same apparatus as gateway server **102**, or may be removed from gateway server **102**. In some embodiments, a firewall **103** may not be present.

In some example embodiments, gateway server **102** may be embodied as or comprise one or more computing devices. In some example embodiments, gateway server **102** may be implemented as a distributed system or a cloud based entity that may be implemented within network **100**. In this regard, gateway server **102** may comprise one or more servers, a server cluster, one or more network nodes, a cloud computing infrastructure, some combination thereof, or the like. In some embodiments, gateway server **102** may be implemented in the same apparatus as one or more requestor(s) **104**.

Additionally or alternatively, in some example embodiments, gateway server **102** may be implemented as a web service or otherwise comprise a web service. It will be appreciated that implementing gateway server **102** as a web service is cited as a non-limiting example, and should not be construed to narrow the scope or spirit of the disclosure in any way. An example embodiment of gateway server **102** is illustrated in FIG. **2** and is described in further detail hereinafter.

Continuing with FIG. **1**, system **101** may also include one or more private data center(s) **120**. Private data center(s) **120** may be operated by a third party and/or administered independently from cloud data center **106**. A private data center(s) **120** may comprise one or more servers, a server cluster, one or more network nodes, a cloud computing infrastructure, some combination thereof, or the like. Additionally or alternatively, private data center **120** may be protected by a firewall such as firewall **122** or **122***a*, which may be implemented on any apparatus within private data center **120**. A private data center **120** may comprise any number of agents, such as **128** and **128***a*, which may be configured to communicate with gateway server **102** via network **100**. Within a single private data center **120** there may be any number of agents. For simplicity sake, example embodiments described herein will refer to agent **128** or agent(s) **128**, which may be indicative of any of the agent(s) **128**, **128***a*, etc. An agent **128** may be an application server, database, or any apparatus configured to access data within the private data center. An example embodiment of an agent(s) **128** is illustrated in FIG. **2** and is described in further detail hereinafter.

Continuing with FIG. **1**, system **101** may additionally and optionally comprise any number of user terminals **110**, which may, for example, be embodied as a laptop computer, tablet computer, mobile phone, desktop computer, workstation, or other like computing device. A user terminal **110** may be remote from the cloud data center **106** and/or private data center(s) **120**, in which case the user terminal **110** may communicate with any of the respective apparatuses via network **100**. Additionally or alternatively, the user terminal **110** may be implemented on cloud data center **106** and/or private data center(s) **120**. User terminal(s) **110** may be used to access a web application, for example, in communication with requestor(s) **104**. Communication between user terminal(s) **110** and requestor(s) **104** may occur via network **100** and/or gateway server **102**.

FIG. **2** illustrates a gateway server **102** and or agent(s) **128** in further detail, in accordance with some example embodiments. However, it should be noted that the components, devices, and elements illustrated in and described with respect to FIG. **2** below may not be mandatory and thus some may be omitted in certain embodiments. For example, while FIG. **2** illustrates a requestor communication manager **220** and an agent communication manager **222**, as described in more detail below, these components may be associated with the gateway server **102**, but not the agent(s) **128**. Additionally, some embodiments may include further or different components, devices, or elements beyond those illustrated in and described with respect to FIG. **2**.

Continuing with FIG. **2**, processing circuitry **210** may be configured to perform actions in accordance with one or more example embodiments disclosed herein. In this regard, the processing circuitry **210** may be configured to perform and/or control performance of one or more functionalities of the gateway server **102** and/or agent(s) **128** in accordance with various example embodiments. The processing circuitry **210** may be configured to perform data processing, application execution, and/or other processing and management services according to one or more example embodiments. In some embodiments, the gateway server **102**, agent(s) **128**, or a portion(s) or component(s) thereof, such as the processing circuitry **210**, may be embodied as or comprise a circuit chip. The circuit chip may constitute means for performing one or more operations for providing the functionalities described herein.

In some example embodiments, the processing circuitry **210** may include a processor **212** and, in some embodiments, such as that illustrated in FIG. **2**, may further include memory **214**. The processing circuitry **210** may be in communication with or otherwise control a requestor communication manager **220**, an agent communication manager **222**, user interface **216**, and/or a communication interface **218**. As such, the processing circuitry **210** may be embodied as a circuit chip (e.g., an integrated circuit chip) configured (e.g., with hardware, software, or a combination of hardware and software) to perform operations described herein.

The processor **212** may be embodied in a number of different ways. For example, the processor **212** may be embodied as various processing means such as one or more of a microprocessor or other processing element, a coprocessor, a controller, or various other computing or processing devices including integrated circuits such as, for example, an ASIC (application specific integrated circuit), an FPGA (field programmable gate array), or the like. Although illustrated as a single processor, it will be appreciated that the processor **212** may comprise a plurality of processors. The plurality of processors may be in operative communication with each other and may be collectively configured to perform one or more functionalities of gateway server **102** and/or agent(s) **128** as described herein. The plurality of processors may be embodied on a single computing device or distributed across a plurality of computing devices collectively configured to function as the gateway server **102** and/or agent(s) **128**. In some example embodiments, the processor **212** may be configured to execute instructions stored in the memory **214** or otherwise accessible to the processor **212**. As such, whether configured by hardware or by a combination of hardware and software, the processor **212** may represent an entity (e.g., physically embodied in circuitry—in the form of processing circuitry **210**) capable of performing operations according to embodi-

ments of the present invention while configured accordingly. Thus, for example, when the processor **212** is embodied as an ASIC, FPGA, or the like, the processor **212** may be specifically configured hardware for conducting the operations described herein. Alternatively, as another example, when the processor **212** is embodied as an executor of software instructions, the instructions may specifically configure the processor **212** to perform one or more operations described herein.

In some example embodiments, the memory **214** may include one or more non-transitory memory devices such as, for example, volatile and/or non-volatile memory that may be either fixed or removable. In this regard, the memory **214** may comprise a non-transitory computer-readable storage medium. It will be appreciated that while the memory **214** is illustrated as a single memory, the memory **214** may comprise a plurality of memories. The plurality of memories may be embodied on a single computing device or may be distributed across a plurality of computing devices collectively configured to function as the gateway server **102** and/or agent(s) **128**. The memory **214** may be configured to store information, data, applications, instructions and/or the like for enabling the gateway server **102** and/or agent(s) **128** to carry out various functions in accordance with one or more example embodiments. For example, the memory **214** may be configured to buffer input data for processing by the processor **212**. Additionally or alternatively, the memory **214** may be configured to store instructions for execution by the processor **212**. As yet another alternative, the memory **214** may include one or more databases that may store a variety of files, contents, or data sets. Among the contents of the memory **214**, applications may be stored for execution by the processor **212** to carry out the functionality associated with each respective application. In some cases, the memory **214** may be in communication with one or more of the processor **212**, user interface **216**, and/or communication interface **218**, for passing information among components of gateway server **102** and/or agent(s) **128**.

The user interface **216** may be in communication with the processing circuitry **210** to receive an indication of a user input at the user interface **216** and/or to provide an audible, visual, mechanical, or other output to the user. As such, the user interface **216** may include, for example, a keyboard, a mouse, a joystick, a display, a touch screen display, a microphone, a speaker, and/or other input/output mechanisms. As such, the user interface **216** may, in some example embodiments, provide means for user control of managing or processing data access operations and/or the like. In some example embodiments in which the gateway server **102** and/or agent(s) **128** is embodied as a server, cloud computing system, or the like, aspects of user interface **216** may be limited or the user interface **216** may not be present. In some example embodiments, one or more aspects of the user interface **216** may be implemented on a user terminal **110**. Accordingly, regardless of implementation, the user interface **216** may provide input and output means in accordance with one or more example embodiments.

The communication interface **218** may include one or more interface mechanisms for enabling communication with other devices and/or networks. In some cases, the communication interface **218** may be any means such as a device or circuitry embodied in either hardware, or a combination of hardware and software that is configured to receive and/or transmit data from/to a network and/or any other device or module in communication with the processing circuitry **210**. By way of example, the communication interface **218** may be configured to enable gateway server **102** to communicate with requestor(s) **104**, and/or agent(s) **128** via network **100**. Accordingly, the communication interface **218** may, for example, include supporting hardware and/or software for enabling wireless and/or wireline communications via cable, digital subscriber line (DSL), universal serial bus (USB), Ethernet, or other methods.

Gateway server **102** may include, in some embodiments, a requestor communication manager **220** configured to perform functionalities associated with communicating with a requestor(s) **104**, as described herein. Processor **212** (or the processing circuitry **210**) may be embodied as, include, or otherwise control the requestor communication manager **220**. As such, the requestor communication manager **220** may be embodied as various means, such as circuitry, hardware, a computer program product comprising computer readable program instructions stored on a computer readable medium (for example, the memory **214**) and executed by a processing device (for example, the processor **212**), or some combination thereof. Requestor communication manager **220** may be capable of communication with one or more of the processor **212**, memory **214**, user interface **216**, and communication interface **218** to access, receive, and/or send data as may be needed to perform one or more of the functionalities of the requestor communication manager **220** as described herein.

Gateway server **102** may further include, in some embodiments, an agent communication manager **222** configured to perform functionalities associated with communication with an agent(s) **128**, as described herein. Processor **212** (or the processing circuitry **210**) may be embodied as, include, or otherwise control the agent communication manager **222**. As such, the agent communication manager **222** may be embodied as various means, such as circuitry, hardware, a computer program product comprising computer readable program instructions stored on a computer readable medium (for example, the memory **214**) and executed by a processing device (for example, the processor **212**), or some combination thereof. Agent communication manager **222** may be capable of communication with one or more of the processor **212**, memory **214**, user interface **216**, and communication interface **218** to access, receive, and/or send data as may be needed to perform one or more of the functionalities of the agent communication manager **222** as described herein. In some example embodiments in which the gateway server **102** is embodied as a server cluster, cloud computing system, or the like, requestor communication manager **220** and agent communication manager **222** may be implemented on different apparatuses.

FIGS. **3**A, **3**B and **4** are flowcharts of operations according to some example embodiments. Operations illustrated in FIGS. **3**A, **3**B, and **4** may be performed respectively by a gateway server **102** and/or agent(s) **128**, and, more particularly, may be performed by, with the assistance of, and/or under the control of one or more of the processing circuitry **210**, processor **212**, memory **214**, user interface **216** and/or communication interface **218**. FIGS. **3**A and **3**B illustrate operations that may be performed by requestor communication manager **220** and agent communication manger **222**, respectively. FIG. **4** illustrates operations that may be performed by processor **212** of agent **128**. The communication interface **218** of both the gateway server **102** and/or agent **128** may be used to communicate between gateway server **102** and agent **128** over network **100**.

Turning to FIG. **3**A, a process by which gateway server **102** may manage communication to and from requestor(s) **104** in accordance with one embodiment of the invention is illustrated. At operation **300**, requestor communication manager **220**, for example, may receive a request and agent identifier from a requestor **104** via communication interface **218**. The

request may comprise a request for retrieval of data stored in a private data center, a request to update and/or save data in the private data center, and/or the like. The agent identifier may be any identifier sent by requestor **104** that may be interpreted by gateway server **102** to identify the agent **128** as the intended recipient of the request. As such, an agent identifier may comprise a customer identifier, particularly in instances where gateway server **102** is configured to communicate with private data center(s) **120** administered by various third parties. In some embodiments, an agent identifier may comprise a customer-agent pair, including a customer identifier, and agent identifier. This may be particularly advantageous in instances where a customer's private data center **120** comprises more than one agent **128**. Additionally or alternatively, an agent identifier may comprise an application name and/or service name associated with an agent application server and/or web service, for example. Regardless of implementation, an agent identifier may comprise any information or data that may be interpreted by gateway server **102** to identify agent(s) **128** as a destination to transmit a request.

Continuing to operation **310**, requestor communication manager **220** may determine whether or not an agent associated with the agent identifier is registered with the gateway server **102**. Such registration may occur prior to operations described herein, and may comprise installing compatible instructions and/or a security certificate on, for example, memory **214** of agent(s) **128**. Upon registration of agent(s) **128**, gateway server **102** may receive an agent identifier, as described herein, to store on memory **214**. Returning to operation **310**, requestor communication manager **220** may determine if an agent is registered by accessing registered agent identifiers on memory **214**. In an instance in which an agent identifier received from a requestor **104** is not associated with a registered agent, at operation **312**, requestor communication manager **220** may return an error to requestor **104** indicating that agent **128** is unregistered and the request may not be processed.

In instances in which an agent is determined to be registered, at operation **320**, gateway server **102**, and, in particular, the requestor communication manager **220**, may generate a correlation identifier to associate with the request. The correlation identifier may be a unique identifier associated with the request and may assist the requestor communication manager **220** in returning a response to the correct requestor **104**. At operation **322**, requestor communication manager **220** may add the request, agent identifier, and/or correlation identifier as a request item to a request queue. Gateway server **102** may comprise one or more request queues, in which case a request queue may be associated with an agent **128**. The request queue(s) may be stored on memory **214** of gateway server **102**. Additionally or alternatively, a request item may be saved to any other data structure on memory such as memory **214**. In some embodiments, a request item may not be saved to persistent memory, and operation **322** may be skipped.

At operation **326**, requestor communication manager **220** may query a response queue for a response with the same correlation identifier as generated for the request. The response queue and process of queuing responses is described in further detail with respect to FIG. **3**B. If a corresponding response is identified in a response queue, at operation **328**, the requestor communication manager **220** may remove the response from the queue and route the response to the requestor **104** that awaits a response.

According to some embodiments, a request item may remain in a request queue until a corresponding response is received by gateway server **102**. Continuing to operation **330**, if a request item remains in a queue longer than a specified time, requestor communication manager **220** may remove a timed out request item from the request queue, such as illustrated by operation **332**, and/or transmit an error back to the requestor **104** that originated the request, such as illustrated by operation **312**. In some embodiments, a request item may be removed from a queue, but a corresponding response may not be received within a specified time frame. In this scenario, requestor communication manager **220** may transmit an error back to the requestor, but may not need to make any further updates to the request queue.

Such an error may be transmitted by communication interface **218**. The specified time used by processor **212**, for example, to determine that a request timeout has occurred, may be predefined, dynamically determined by processor **212**, and/or retrieved from memory **214**.

FIG. **3**B illustrates a process, which may occur asynchronously from the process illustrated in FIG. **3**A, whereby gateway server **102**, and, in particular, the agent communication manager **222**, may manage communication to and from agent(s) **128**. At operation **350**, agent communication manager **222** may receive an agent message from an agent **128**, via communication interface **218**, for example. As illustrated by operation **352**, an agent message may be a response or a polling message to ask agent communication manager **222** if there is any work to do, or, for example, if there are any unanswered requests intended for the agent **128** waiting in a request queue.

As illustrated by operation **354**, in an instance in which agent **128** has transmitted a polling message, agent communication manager **222** may query a request queue for a request item intended for the polling agent **128**. In this regard, agent communication manager **222** may determine that a request item is intended for a specific agent **128** based on the agent identifier associated with the request item, and/or by the queue the request item is in, in instances where request queues correspond to a specific agent. At operation **360**, if a request item for the agent is present in a queue, agent communication manager **222** may remove the request item from the queue. At operation **370**, agent communication manager **222** may transmit, or route the request and correlation identifier associated with the removed request item to agent **128**. Such a transmission may occur via communication interface **218**.

Returning to operation **354**, if agent communication manager **222** determines there is no work for an agent **128**, in response to the agent's polling message, at operation **372**, agent communication manager **222** may message agent **128**, via communication interface **218**, to let the agent know there is no work to do.

Returning to operation **352**, if agent communication manager **222** receives a response from an agent **128**, the gateway server may add the response, comprising an answer and correlation identifier, to a response queue, as illustrated by operation **380**. An answer may comprise requested data, a confirmation that an update has occurred, and/or any other answer or response to a request. According to some embodiments, an agent response may comprise a security certificate processed by gateway server **102** to validate the response is from the expected agent **128**. Once the response has been added to a queue, agent communication manager **222** may determine, at operation **354**, whether additional requests are waiting for a response from the agent and proceed accordingly, as described above.

While not shown, in another example embodiment, the agent communication manager may not wait to receive a polling message from the agent before transmitting a request to that agent. Instead, the agent communication manager may

transmit the request upon determining that a request intended for that agent has been placed in a queue (e.g., a queue associated with that agent). In one embodiment, the polling technique illustrated in FIG. **3**B may be used when the gateway server and agent are communicating via HTTPS and/or comet, whereas the latter scenario may be implemented when the gateway server and agent are communicating via WebSocket or Reverse HTTP.

Processes such as those illustrated by FIG. **3**A and FIG. **3**B may be performed asynchronously. As such, a requestor communication manager **220** may be configured to perform operations of FIG. **3**A independently from an agent communication manager **222** configured to perform operations of FIG. **3**B, and the two asynchronous processes running on gateway server **102** may provide a method of communication between requestor(s) **104** and agent(s) **128**.

Moving on to FIG. **4**, which illustrates operations performed by an agent **128** in accordance with some embodiments, at operation **400**, an agent **128** may receive, via communication interface **218**, for example, a request and a correlation identifier. The request may be formatted such that it may be interpreted by agent **128**. Processor **212** of agent **128** may, at operation **410**, perform an operation associated with the request that may comprise retrieving or updating data on some apparatus of private data center **120**.

At operation **420**, agent **128** may transmit a response to gateway server **102** via communication interface **218**. The response may comprise an answer, such as requested data and/or confirmation of an operation, a correlation identifier, and/or a security certificate. At operation **430**, agent **128** may save any information regarding the request and/or response to an audit log, on memory **214**, for example. The information saved to the audit log may comprise date and time stamps, unique identifiers associated with requests and/or responses, copies of data retrieved and/or updated, Internet Protocol addresses or other identifiers of request originators, and/or any information associated with the request and/or response. Such an audit log may be useful in determining and/or analyzing data usage in private data center(s) **120**.

FIG. **5** is a block diagram according to an example embodiment, also illustrating operations according to example embodiment that may be performed in conjunction with operations of FIGS. **3**A, **3**B and **4**. The diagram illustrates a cloud data center **106** comprising a requestor **104** and gateway server **102** as well as a private data center **120** comprising an agent **128**. The operations illustrated show how the apparatuses may perform some operations described herein utilizing HTTPS and/or Comet protocol. At operation **500**, gateway server **102**, via communication interface **218** may receive a request from a requestor **104**, as described with respect to operation **300** of FIG. **3**A, such as "get name(4)", which may, in this example indicate a request for a name of a customer number 4. At operation **510**, an agent **128**, via communication interface **218**, may poll gateway server **102** to see if there are any pending requests, or more particularly, if there are any unanswered requests in a request queue, intended for agent **128**. In this regard, agent **128** may repeatedly transmit HTTPS messages, or requests, to gateway server **102**. If processor **212** of gateway server **102** determines there is an unanswered request intended for the polling agent **128** in a request queue, at operation **520**, gateway server **102**, via communication interface **218**, may transmit an HTTPS message, or response, indicating the data request, such as, in this example, "get name(4)," and the associated correlation identifier, such as, "1234." In this regard, operation **520** may be exemplary of operation **340**. At operation **530**, in accordance with operation **420**, communication interface **218** of agent **128** may transmit an HTTPS message, or request, comprising an answer to the request ("John"), correlation id "**1234**," and/or a security certificate. At operation **540**, gateway server **102** may transmit, via communication interface **218**, an HTTPS message, or response, as confirmation of receiving the answer from agent **128**. At operation **550**, such as in operation **328**, gateway server **102**, via communication interface **218**, may transmit the answer to the appropriate requestor **104**.

The operations of FIG. **5** are provided as a non-limiting example embodiment that may be implemented using HTTPS and/or Comet, but it will be appreciated that embodiments described herein may be implemented by a variety of methods and/or protocols. Another example implementation of embodiments described herein may utilize WebSocket and/or reverse HTTP for the connection between agent **108** and gateway server **102**.

FIGS. **3**A, **3**B, **4**, and **5** illustrate operations of a method, apparatus, and computer program product according to some example embodiments. It will be understood that each operation of the flowcharts or diagrams, and combinations of operations in the flowcharts or diagrams, may be implemented by various means, such as hardware and/or a computer program product comprising one or more computer-readable mediums having computer readable program instructions stored thereon. For example, one or more of the procedures described herein may be embodied by computer program instructions of a computer program product. In this regard, the computer program product(s) which embody the procedures described herein may comprise one or more memory devices of a computing device (for example, the memory **214**) storing instructions executable by a processor in the computing device (for example, by the processor **212**, requestor communication manager **220**, or agent communication manager **222**). In some example embodiments, the computer program instructions of the computer program product(s) which embody the procedures described above may be stored by memory devices of a plurality of computing devices. As will be appreciated, any such computer program product may be loaded onto a computer or other programmable apparatus (for example, gateway server **102**, agent **128**, and/or other apparatus) to produce a machine, such that the computer program product including the instructions which execute on the computer or other programmable apparatus creates means for implementing the functions specified in the flowchart block(s). Further, the computer program product may comprise one or more computer-readable memories on which the computer program instructions may be stored such that the one or more computer-readable memories can direct a computer or other programmable apparatus to function in a particular manner, such that the computer program product may comprise an article of manufacture which implements the function specified in the flowchart block(s). The computer program instructions of one or more computer program products may also be loaded onto a computer or other programmable apparatus (for example, gateway server **102**, agent **128**, and/or other apparatus) to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus implement the functions specified in the flowchart block(s).

Accordingly, blocks of the flowcharts support combinations of means for performing the specified functions and combinations of operations for performing the specified functions. It will also be understood that one or more blocks of the flowcharts, and combinations of blocks in the flowcharts, can

be implemented by special purpose hardware-based computer systems which perform the specified functions, or combinations of special purpose hardware and computer instructions.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe example embodiments in the context of certain example combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

The invention claimed is:

1. A method comprising:

receiving a request and an agent identifier from a requestor;

generating, by a processor, a correlation identifier associated with the request;

asynchronously adding the request, agent identifier, and associated correlation identifier as a request item to a request queue associated with the agent identifier, wherein the request queue is identified from a plurality of request queues, each associated with a respective agent;

retrieving the request item from the request queue and routing the request and associated correlation identifier to an agent associated with the agent identifier associated with the request queue from which the request item was retrieved;

receiving an agent response comprising an answer and the correlation identifier;

adding the agent response to a response queue;

retrieving the agent response from a response queue; and

transmitting the answer associated with the agent response to a requestor based on the correlation identifier associated with the agent response;

wherein the receiving the request, the generating of the correlation identifier, and the transmitting of the answer are performed asynchronously from the routing of the request and the receiving of the agent response.

2. A method according to claim **1**, wherein the agent response further comprises a security certificate identifying a registered agent.

3. A method according to claim **1**, further comprising transmitting an error response to a requestor in an instance when a response to a request is not received within a specified time limit.

4. A method according to claim **1**, further comprising transmitting an error response to a requestor in an instance when an agent identifier is not registered.

5. A method according to claim **1**, wherein

the request and associated correlation identifier is routed to the agent in the form of a hypertext transfer protocol secure response, in response to a polling hypertext transfer protocol secure request received from the agent; and

the agent response is received as a hypertext transfer protocol secure request.

6. A method according to claim **1**, wherein the request and associated correlation identifier is routed to the agent via a WebSocket connection and the agent response is received via the WebSocket connection.

7. A method according to claim **1**, wherein the agent identifier comprises at least one of a customer identifier, application name, or service name.

8. A computer program product comprising at least one non-transitory computer-readable medium having computer-readable program instructions stored therein, the computer-readable program instructions comprising instructions, which when performed by an apparatus, are configured to cause the apparatus to at least:

receive a request and an agent identifier from a requestor;

generate a correlation identifier associated with the request;

asynchronously add the request, agent identifier, and associated correlation identifier as a request item to a request queue associated with the agent identifier, wherein the request queue is identified from a plurality of request queues, each associated with a respective agent;

retrieve the request item from the request queue and route the request and associated correlation identifier to an agent associated with the agent identifier associated with the request queue from which the request item was retrieved;

receive an agent response comprising an answer and the correlation identifier;

add the agent response to a response queue;

retrieve the agent response from a response queue; and

transmit the answer associated with the agent response to a requestor based on the correlation identifier associated with the agent response; and

wherein the receiving the request, the generating of the correlation identifier, and the transmitting of the answer are performed asynchronously from the routing of the request and the receiving of the agent response.

9. A method comprising:

managing communication with a requestor asynchronously from managing communication with an agent,

wherein managing communication with the requestor comprises:

receiving a request and an agent identifier from a requestor;

generating, by a processor, a correlation identifier associated with the request;

adding the request, agent identifier, and associated correlation identifier as a request item to a request queue associated with the agent identifier, wherein the request queue is identified from a plurality of request queues, each associated with a respective agent;

asynchronously from the adding the request, determining that an agent response comprising the correlation identifier has been received in a response queue;

retrieving the agent response from the response queue; and

transmitting an answer associated with the agent response to the requestor based on the correlation identifier associated with the agent response; and

wherein managing communication with the agent comprises:

determining that a request comprising an agent identifier associated with the agent has been received in the request queue;

retrieving the request item from the request queue;

transmitting the request and the associated correlation identifier to the agent associated with the agent identifier;

receiving an agent response comprising an answer and the correlation identifier; and

adding the agent response to the response queue.

10. An apparatus for processing data requests, the apparatus comprising:

processing circuitry configured to manage communication with a requestor, said processing circuitry configured to cause the apparatus to at least:

receive a request and an agent identifier from a requestor;

generate a correlation identifier associated with the request;

add the request, agent identifier, and associated correlation identifier as a request item to a request queue associated with the agent identifier, wherein the request queue is identified from a plurality of request queues, each associated with a respective agent;

asynchronously from the adding the request, determine that an agent response comprising the correlation identifier has been received in a response queue;

retrieve the agent response from the response queue; and

transmit an answer associated with the agent response to the requestor based on the correlation identifier associated with the agent response; and

processing circuitry configured to manage communication with an agent, said processing circuitry configured to cause the apparatus to at least:

determine that a request comprising an agent identifier associated with the agent has been received in the request queue;

retrieve the request item from the request queue;

transmit the request and the associated correlation identifier to the agent associated with the agent identifier;

receive an agent response comprising an answer and the correlation identifier; and

add the agent response to the response queue.

* * * * *